Catalogue no. 82-003-X
ISSN 1209-1367

Health Reports

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Release date: April 20, 2016

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0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p} preliminary
^{r} revised
x suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E} use with caution
F too unreliable to be published
* significantly different from reference category ($p < 0.05$)

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Using a Betabinomial distribution to estimate the prevalence of adherence to physical activity guidelines among children and youth

by Didier Garriguet

Abstract

Background: Estimates of the prevalence of adherence to physical activity guidelines in the population are generally the result of averaging individual probability of adherence based on the number of days people meet the guidelines and the number of days they are assessed. Given this number of active and inactive days (days assessed minus days active), the conditional probability of meeting the guidelines that has been used in the past is a Beta (1 + active days, 1 + inactive days) distribution assuming the probability p of a day being active is bounded by 0 and 1 and averages 50%. A change in the assumption about the distribution of p is required to better match the discrete nature of the data and to better assess the probability of adherence when the percentage of active days in the population differs from 50%.

Data and methods: Using accelerometry data from the Canadian Health Measures Survey, the probability of adherence to physical activity guidelines is estimated using a conditional probability given the number of active and inactive days distributed as a Betabinomial(n, α + active days , β + inactive days) assuming that p is randomly distributed as Beta(α, β) where the parameters α and β are estimated by maximum likelihood.

Results: The resulting Betabinomial distribution is discrete. For children aged 6 or older, the probability of meeting physical activity guidelines 7 out of 7 days is similar to published estimates. For pre-schoolers, the Betabinomial distribution yields higher estimates of adherence to the guidelines than the Beta distribution, in line with the probability of being active on any given day.

Interpretation: In estimating the probability of adherence to physical activity guidelines, the Betabinomial distribution has several advantages over the previously used Beta distribution. It is a discrete distribution and maximizes the richness of accelerometer data.

Key words: Accelerometer, Actical, children, moderate-to-vigorous physical activity

Population health surveys routinely use activity monitors to measure physical activity.[1-4] This results in a finite number of days when respondents wear the device and accumulate enough physical activity to meet a predetermined level at which the day will be deemed active. In large samples, a minimum number of wear-days for a minimum number of hours is required in order to have a valid representation of a respondent's activity level. This yields a different number of valid days for each respondent. Each combination of active and valid days can then be used to calculate a probability of adherence to a certain frequency of active days (for example, physical activity guidelines).

In 2008, Troiano[1] reported the probability of adherence to physical activity guidelines for the American population using a method developed by Dodd.[5] The probability of adherence is distributed as a Binomial(n, p) where n represents the number of days and p the probability of being active on any given day. The parameter p is randomly distributed. Assuming that p is unknown but bounded by 0 and 1, p is distributed as a Uniform(0,1). By Bayes' Theorem, the conditional distribution of adherence to the guidelines given a number of active and inactive days is Beta(1 + active days, 1 + inactive days).

When this method was applied to Canadian data,[2] 7% of children met the guidelines of 60 minutes of moderate-to-vigorous physical activity every day. However, because the Beta distribution is continuous, the probability of adherence was estimated as the probability of being active at least 6 out of 7 days, or 85.7% of the time. Estimating adherence 100% of the time is not possible; for example, only one failure in a year would make the person non-adherent.

For pre-schoolers, the physical activity guidelines stipulate at least 180 minutes of activity at any level of intensity every day. Using the method developed by Dodd, the conditional probability of adherence to the guidelines at least 6 out of 7 days, given 7 active days out of 7 valid days, is 71%, and 60% given 5 active days out of 5 valid days. In other words, if all respondents reported 7 valid days and they were active on all those days, the prevalence of adherence to the guidelines in the population would be 71%. This reflects the finite number of days and the original assumption that, on average, 50% of the days collected are active. For example, 14 active days out of 14 valid days would result in a prevalence of 90%.

More than 90% of the days collected for pre-schoolers are active (that is, 90% of the 4,000 days collected for this population), far from the 50% average assumed in the Uniform(0,1) distribution. As well, more than 80% of pre-schoolers met the guidelines on every valid day they reported.[4] According to Dodd's method, the prevalence of adherence to the guidelines at least 6 out of 7 days would be estimated at 61.6% based on 7 days of data in 2009-to-2011, and 44.7% based on 5 days of data in 2012-to-2013. This discrepancy is larger than expected.

These outcomes suggest that a different assumption about the distribution of p is warranted. Ideally, the conditional probability using the new distribution would: result in little change in the previously published prevalence of adherence to physical activity guidelines among children aged 6 or older; reconcile the prevalence of adherence for pre-schoolers with estimates using all valid days; and be a discrete distribution allowing estimation of adherence every day.

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This study proposes a new distribution for p and compares estimates of the prevalence of adherence to the guidelines from this new method with the existing one.

Distribution of probability of adherence

The conceptual model developed by Dodd remains the same; only the assumption about the distribution of p changes. The probability of adherence is distributed as a Binomial(n, p), where n represents the number of days and p is a randomly distributed variable—rather than assuming that p is distributed as a Uniform(0,1), it is assumed that p is randomly distributed as a Beta(α, β). According to Bayes' Theorem, given k active days out of n valid days and the parameters α and β of the prior Beta distribution, the conditional distribution of p is a Betabinomial distribution BetaBin(n, α, β). The BetaBin distribution is a discrete distribution. The density function is:

$$f(k|n,\alpha,\beta) = \frac{\Gamma(n+1)}{\Gamma(k+1)\Gamma(n-k+1)}\frac{\Gamma(k+\alpha)}{\Gamma(n+\alpha+\beta)}\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}$$

where k is the number of active days; n is the number of valid days; and the parameters α and β are the parameters of the prior Beta distribution.

The parameters α and β can be estimated by maximum-likelihood using the empirical distribution of the probability of a day being active. This can be done using a PROC NLMIXED in SAS version 9.3.

The conditional probability of adherence to the physical activity guidelines for a specific combination of active and inactive days can be obtained by adding the number of active days to α and the number of inactive days to β. These conditional probabilities can then be assigned to a respondent according to the respondent's pattern of active and inactive days.

The estimated population prevalence is the weighted average of these individual probabilities.[1]

Physical activity guidelines

The physical activity guidelines for 3- and 4-year–olds recommend at least 180 minutes of activity at any intensity every day.[6] The guidelines for 5- to 17-year-olds advise at least 60 minutes of moderate-to-vigorous physical activity (MVPA) every day.[7,8]

In this study, "meeting the guidelines every day" is defined as the probability of meeting the guidelines at least 6 out of 7 days when using the Beta distribution approach, and 7 out of 7 days when using the Betabinomial distribution.

Data source

The data are from three cycles of the Canadian Health Measures Survey (CHMS): 2007 to 2009 (cycle 1), 2009 to 2011 (cycle 2), and 2012 to 2013 (cycle 3). The CHMS collected data from private household residents aged 3 to 17 in cycles 2 and 3; in cycle 1, collection started at age 6. Residents of Indian Reserves, institutions, some remote regions, or areas with low population density, and full-time members of the Canadian Forces were excluded. The sample represents more than 96% of the Canadian population.[9-11] Ethics approval was obtained from Health Canada's Research Ethics Board.[12] Detailed information about the content and sample design of the CHMS is available elsewhere.[9-12]

The CHMS involves an in-person interview at the respondent's residence to gather sociodemographic, health and lifestyle information, and a subsequent a visit to a mobile examination center (MEC) for direct physical measures. Upon completion of the MEC visit, ambulatory respondents were asked to wear an Actical accelerometer (Phillips – Respironics, Oregon, USA) over their right hip on an elasticized belt during their waking hours for 7 consecutive days.

Individual cycles

Cycle 1 data were collected at 15 sites; cycle 2 and 3 data were collected at 18 and 16 sites, respectively. The combined response rates for the activity monitor, including the response rates for the household (69.6%, 75.9%, 74.1%), household questionnaire (88.3%, 90.5%, 88.4%), MEC (84.8%, 81.7%, 78.8%), and returning the activity monitor (81.2%, 77.6%, 75.7%) with at least 3 valid days for 3- to 5-year-olds and 4 valid days otherwise were 41.8%, 44.1% and 38.3% for cycles 1, 2 and 3, respectively. Non-

Table 1
Parameters estimation of prior Beta distribution, by age group and time period, household population aged 3 to 17, Canada, 2007 to 2013

Age group/ Time period	Number of respondents	Probability of a day being active	Beta parameters	
			α	β
Ages 3 to 4				
2009 to 2011	290	96.8	3.085	0.114
2009 to 2011†	290	92.7	1.296	0.114
2012 to 2013	276	90.5	1.056	0.127
2009 to 2013	566	91.7	1.154	0.119
Age 5				
2009 to 2011	169	55.7	0.336	0.318
2009 to 2011†	168	60.4	0.242	0.192
2012 to 2013	131	64.6	0.524	0.188
2009 to 2013	299	63.0	0.303	0.183
Ages 6 to 17				
2007 to 2009	1,473	40.3	0.247	0.394
2009 to 2011	1,507	33.0	0.204	0.425
2012 to 2013	1,328	41.6	0.229	0.351
2007 to 2011	2,973	36.3	0.222	0.406
2007 to 2013	4,297	37.9	0.224	0.387
2009 to 2013	2,835	36.9	0.214	0.383

† to be comparable with cycle 3, cycle 2 data for 3- to 5-year-olds were adjusted for 15-second epochs excluding days 6 and 7
Source: Canadian Health Measures Survey, 2007 to 2013.

response models were created using all information available at a specific level. Weights were adjusted accordingly.[9-11] Table 1 shows the number of respondents per cycle.

Combined cycles

Data from consecutive CHMS cycles can be combined to increase the sample size. The total population for the combined cycles was derived from the average population total for each collection period. Each cycle was adjusted based on region and the number of sites. Information about combining CHMS cycles is available elsewhere.[13]

Respondents aged 6 to 17 in cycles 1 through 3 can be combined in three ways: cycles 1 and 2 (2007 to 2011), cycles 2 and 3 (2009 to 2013), and all three cycles (2007 to 2013). Respondents aged 3 and 4 can be combined for cycles 2 and 3 (2009 to 2013), but accelerometry data for children of these ages were collected using different epoch lengths (60 seconds in cycle 2; 15 seconds in cycle 3). Also, because of the memory capacity of the Actical accelerometer, a maximum of 5.6 days, rather than 7, is available for cycle 3. Therefore, in the combined sample, days 6 and 7 for cycle 2 are excluded. A correction factor can be used to adjust the cycle 2 data into 15-second epochs[14] (Text table 1).

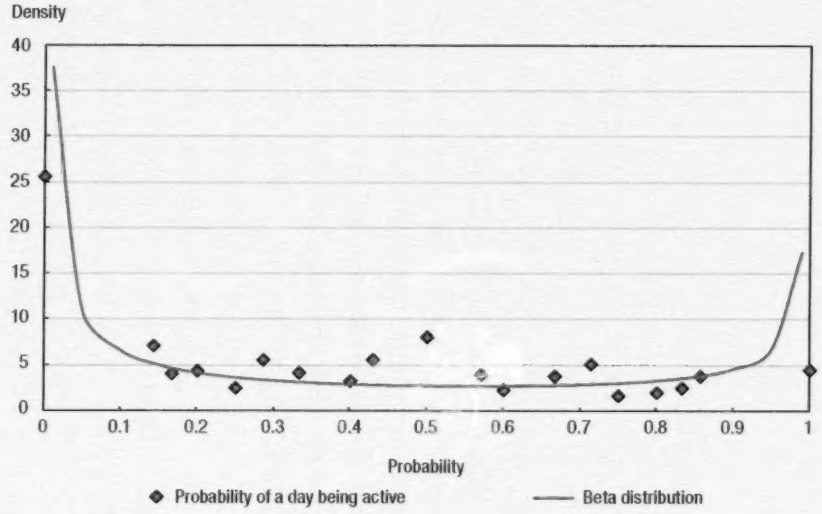
Although respondents aged 5 are subject to the same physical activity guidelines as 6- to 17-year-olds, data for these children were collected using the methodology for 3- to 4-year-olds. Five-year-olds were analyzed separately, adjusting the 60-second epoch data to 15-second epochs, similar to 3- and 4-year-olds.

Text table 1
Regression equations for association between 60- and 15-second epoch data for physical activity outcome variables

	Regression equation (x = 60-second epoch, y = 15-second epoch)
MVPA (minutes per day)	y = 0.78x + 15.76
TPA (minutes per day)	y = 0.79x + 4.54

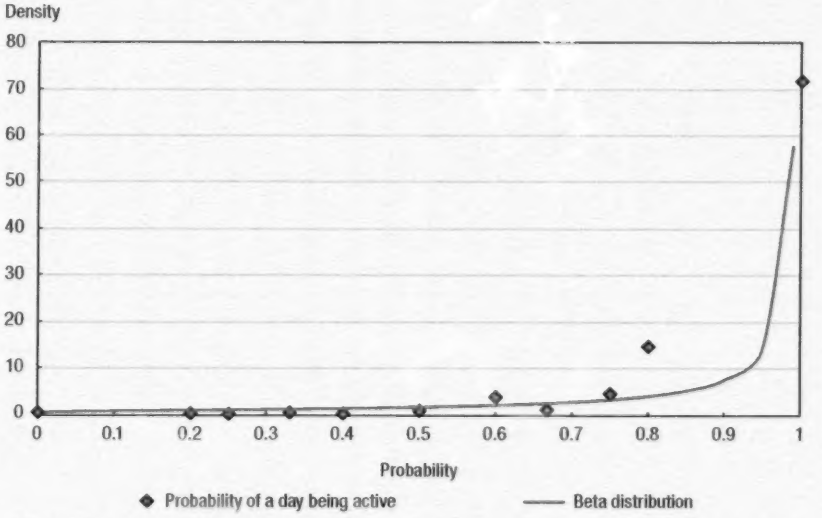
MVPA = moderate-to-vigorous physical activity
TPA = total physical activity
Source: Colley RC, Harvey A, Grattan KP, Adamo K. Impact of accelerometer epoch length on physical activity and sedentary behavior. *Health Reports* 2014; 25(1): 3-9.

Figure 1
Probability of a day being active and modelled Beta distribution, household population aged 6 to 17, Canada, 2009 to 2013



Source: Canadian Health Measures Survey, 2009 to 2013 combined.

Figure 2
Probability of a day being active and modelled Beta distribution, household population aged 3 to 4, Canada, 2009 to 2013



Source: Canadian Health Measures Survey, 2009 to 2013 combined.

Accelerometry data reduction

The Actical accelerometer measures and records time-stamped acceleration in all directions, providing an index of physical activity intensity. The Actical has been validated to measure physical activity in children,[15,16] including pre-schoolers.[17,18]

The monitors were initialized to start collecting data in one-minute epochs (except for children aged 3 to 5 in cycle 3 for whom epoch length was set to 15 seconds) at midnight following the MEC appointment. All data were blind to respondents while they wore the device. Respondents received a prepaid envelope in which to return the monitors to Statistics Canada, where the data were downloaded, and the monitor was checked to ensure that it was still within the manufacturer's calibration specifications.[19]

The digitized values were summed over the epoch length, resulting in a count per epoch. A valid day was defined as 5 or more hours of wear-time[20] for 3- to 5-year-olds and 10 hours for older children. Wear-time was determined by subtracting non wear-time from 24 hours. For 3- to 5- year-olds, non wear-time was defined as at least 240 intervals of 15 seconds of zero counts with allowance for 30 seconds of counts between 0 and 25.[1,20] For 6- to 17-year-olds, non wear-time was defined as at least 60 consecutive minutes of zero counts, with allowance for 2 minutes of counts between 0 and 100.

Cut-points were used to determine physical activity intensity (sedentary, light, moderate-to-vigorous). The cut-point for moderate-to-vigorous physical activity (MVPA) was 1,500 counts per minute (cpm)[16] for respondents aged 6 to 17, and 1,150 cpm or 288 counts per 15 seconds (cp15s) for respondents aged 3 to 5.[17] A cut-point of 100 cpm or 25 cp15s according to epoch length was used to distinguish sedentary from light physical activity (LPA) intensity.[21] Total physical activity was defined as the sum of LPA and MVPA.

Respondents aged 3 to 5 with at least 3 valid days and those aged 6 to 17 with at least 4 valid days were retained for analysis.

Table 2
Probability of meeting physical activity guidelines according to two conditional distributions, given *a* active days and *n* valid days, household population aged 3 to 4, Canada, 2009 to 2013

		Conditional distribution			
		Beta[†]	BetaBin[‡]		
Number of valid days (*n*)	Number of active days (*a*)	All years	2009 to 2011	2009 to 2011[§]	2012 to 2013
7	7	0.709	0.940	...	...
7	6	0.320	0.531	...	...
7	5	0.094	0.284	...	...
7	4	0.018	0.143	...	...
7	3	0.002	0.067	...	...
7	2	0.000	0.028	...	...
7	1	0.000	0.010	...	...
7	0	0.000	0.003	...	...
6	6	0.660	0.934	...	...
6	5	0.264	0.501	...	...
6	4	0.065	0.252	...	...
6	3	0.010	0.117	...	...
6	2	0.001	0.049	...	...
6	1	0.000	0.018	...	...
6	0	0.000	0.006	...	...
5	5	0.603	0.928	0.915	0.903
5	4	0.207	0.467	0.394	0.379
5	3	0.042	0.217	0.150	0.139
5	2	0.005	0.091	0.048	0.042
5	1	0.000	0.034	0.012	0.010
5	0	0.000	0.010	0.002	0.001
4	4	0.537	0.921	0.904	0.890
4	3	0.152	0.428	0.344	0.326
4	2	0.023	0.180	0.110	0.099
4	1	0.002	0.066	0.027	0.023
4	0	0.000	0.020	0.004	0.003
3	3	0.460	...	0.889	0.873
3	2	0.100	...	0.285	0.265
3	1	0.010	...	0.070	0.060
3	0	0.000	...	0.011	0.008

... not applicable

[†] probability of meeting physical activity guidelines at least 6 out of 7 days with a Beta(1+ a,1 + n - a)

[‡] probability of meeting physical activity guidelines 7 out of 7 days with a BetaBin(7, α + a, β + n - a)

[§] to be comparable with cycle 3, cycle 2 data for 3- to 5-year-olds were adjusted for 15-second epochs, excluding days 6 and 7

Note: Table 1 contains the parameters α and β of the BetaBin distribution.

Source: Canadian Health Measures Survey, 2009 to 2013.

Table 3
Probability of meeting physical activity guidelines, according to two conditional distributions given *a* active days and *n* valid days, household population aged 5, Canada, 2009 to 2013

		Conditional distribution			
		Beta[†]	BetaBin[‡]		
Number of valid days (*n*)	Number of active days (*a*)	All years	2009 to 2011	2009 to 2011[§]	2012 to 2013
7	7	0.709	0.802	...	...
7	6	0.320	0.381	...	...
7	5	0.094	0.165	...	...
7	4	0.018	0.063	...	...
7	3	0.002	0.020	...	...
7	2	0.000	0.005	...	...
7	1	0.000	0.001	...	...
7	0	0.000	0.000	...	...
6	6	0.660	0.782	...	...
6	5	0.264	0.338	...	...
6	4	0.065	0.129	...	...
6	3	0.010	0.042	...	...
6	2	0.001	0.010	...	...
6	1	0.000	0.002	...	...
6	0	0.000	0.000	...	...
5	5	0.603	0.757	0.843	0.851
5	4	0.207	0.290	0.318	0.334
5	3	0.042	0.093	0.101	0.112
5	2	0.005	0.023	0.024	0.030
5	1	0.000	0.004	0.004	0.005
5	0	0.000	0.000	0.000	0.000
4	4	0.537	0.725	0.820	0.830
4	3	0.152	0.234	0.260	0.278
4	2	0.023	0.059	0.063	0.074
4	1	0.002	0.009	0.009	0.013
4	0	0.000	0.000	0.000	0.001
3	3	0.460	...	0.789	0.802
3	2	0.100	...	0.191	0.213
3	1	0.010	...	0.029	0.038
3	0	0.000	...	0.001	0.003

... not applicable

[†] probability of meeting physical activity guidelines at least 6 out of 7 days with a Beta(1+ a,1 + n - a)

[‡] probability of meeting physical activity guidelines 7 out of 7 days with a BetaBin(7, α + a, β + n - a)

[§] to be comparable with cycle 3, cycle 2 data for 3- to 5-year-olds were adjusted for 15-second epochs excluding days 6 and 7

Note: Table 1 contains the parameters α and β of the BetaBin distribution.

Source: Canadian Health Measures Survey, 2009 to 2013.

Statistical analysis

Prevalence of adherence to the physical activity guidelines given a active days and n valid days was estimated using two conditional distributions:

1. $\text{Prob}(X>=6/7 \mid a, n) \sim \text{Beta}(1+a, 1+n-a)$
2. $\text{Prob}(X=7 \mid a, n, \alpha, \beta) \sim \text{BetaBinomial}(7, \alpha+a, \beta+n-a)$.

All analyses were performed using SAS v9.3 (SAS Institute, Cary, NC) and were based on weighted data. To account for survey design effects (primary sampling units, sites, and stratum), standard errors, coefficients of variation, 95% confidence intervals and paired t-tests were estimated with the bootstrap techniques using 11, 13 and 11 degrees of freedom for cycles 1 through 3. Degrees of freedom were summed when combining cycles. Statistical significance was set at 0.05.

Table 4
Probability of meeting physical activity guidelines according to two conditional distributions, given *a* active days and *n* valid days, household population aged 6 to 17, Canada, 2007 to 2013

		Conditional distribution			
		Beta[†]	BetaBin[‡]		
Number of valid days (*n*)	Number of active days (*a*)	All years	2007 to 2009	2009 to 2011	2012 to 2013
7	7	0.709	0.760	0.743	0.782
7	6	0.320	0.358	0.349	0.368
7	5	0.094	0.154	0.149	0.158
7	4	0.018	0.058	0.056	0.059
7	3	0.002	0.018	0.018	0.019
7	2	0.000	0.004	0.004	0.005
7	1	0.000	0.001	0.001	0.001
7	0	0.000	0.000	0.000	0.000
6	6	0.660	0.736	0.718	0.760
6	5	0.264	0.315	0.306	0.325
6	4	0.065	0.119	0.115	0.122
6	3	0.010	0.038	0.036	0.039
6	2	0.001	0.009	0.009	0.009
6	1	0.000	0.001	0.001	0.001
6	0	0.000	0.000	0.000	0.000
5	5	0.603	0.707	0.687	0.733
5	4	0.207	0.267	0.258	0.276
5	3	0.042	0.085	0.081	0.087
5	2	0.005	0.021	0.019	0.021
5	1	0.000	0.003	0.003	0.003
5	0	0.000	0.000	0.000	0.000
4	4	0.537	0.669	0.647	0.698
4	3	0.152	0.212	0.203	0.220
4	2	0.023	0.052	0.049	0.053
4	1	0.002	0.008	0.007	0.008
4	0	0.000	0.000	0.000	0.000

[†] probability of meeting physical activity guidelines at least 6 out of 7 days with a Beta(1+ a,1 + n - a)

[‡] probability of meeting physical activity guidelines 7 out of 7 days with a BetaBin(7, α + a, β + n - a)

Note: Table 1 contains the parameters α and β of the BetaBin distribution.

Source: Canadian Health Measures Survey, 2007 to 2013.

Results

For each cycle combination (individual or combined) and age group, Table 1 presents the average probability of a day meeting the physical activity guidelines and the parameters α and β of the Beta distribution estimated by maximum likelihood. For children aged 5 and 6- to 17-year-olds, the parameters of the prior Beta distribution have a U-shape (Figure 1); for children aged 3 to 4, the distribution is negatively skewed, with a mode at a probability equal to 1 (Figure 2).

Conditional probabilities for a given number of valid and active days are shown in Tables 2 to 4 for 3- to 4 year-olds, 5-year-olds, and 6- to 17-year-olds, respectively. In all cases, the conditional Betabinomial distribution yields a higher probability of adherence to the physical activity guidelines. The differences are greater for 3- to 4-year-olds than for 6- to 17-year-olds.

The prevalence of adherence to the physical activity guidelines by CHMS cycle and age group according to the two conditional probabilities is presented in Table 5. Because all individual probabilities shown in Tables 2 to 4 are higher with the Betabinomial distribution, paired t-tests comparing the prevalence with the two conditional probabilities show significant differences. Differences among 3- to 4-year-olds range between 25.5 and 28.3 percentage points; differences among 5-year-olds range between 4.2 and 10.9 percentage points; and among 6- to 17-year-olds, between 1.6 and 2.8 percentage points.

Table 5
Prevalence of adherence to physical activity guidelines, by age group and time period, household population aged 3 to 17, Canada, 2007 to 2013

	Conditional distribution					
	Beta[†]			BetaBin[‡]		
		95% confidence interval			95% confidence interval	
Age group/ Time period	%	from	to	%	from	to
Ages 3 to 4						
2009 to 2011	61.6	58.9	64.2	86.1	83.4	88.8
2009 to 2011[§]	47.0	42.6	51.5	75.4	69.2	81.5
2012 to 2013	44.7	41.2	48.3	71.3	66.3	76.2
2009 to 2013	45.9	43.1	48.6	73.3	69.6	77.0
Age 5						
2009 to 2011	13.7	9.4	18.0	17.9	13.0	22.8
2009 to 2011[§]	16.9	12.4	21.4	26.0	19.8	32.2
2012 to 2013	21.3[E]	10.9	31.8	32.9[E]	18.1	47.7
2009 to 2013	19.3	14.4	24.2	29.7	22.8	36.5
Ages 6 to 17						
2007 to 2009	7.4	4.8	10.0	9.7	6.7	12.7
2009 to 2011	4.7	3.4	6.0	6.4	4.8	7.9
2012 to 2013	8.4	5.4	11.4	11.2	7.6	14.8
2007 to 2011	5.9	4.6	7.3	7.9	6.3	9.5
2007 to 2013	6.7	5.4	8.1	8.9	7.4	10.4
2009 to 2013	6.5	4.9	8.0	8.6	6.8	10.4

[E] use with caution

[†] probability of meeting physical activity guidelines at least 6 out of 7 days with a Beta(1+ a,1 + n - a)

[‡] probability of meeting physical activity guidelines 7 out of 7 days with a BetaBin(7, α + a, β + n - a)

[§] to be comparable with cycle 3, cycle 2 data for 3- to 5-year-olds were adjusted for 15-second epochs, excluding days 6 and 7

Source: Canadian Health Measures Survey, 2007 to 2013.

Discussion

Use of a Betabinomial distribution to estimate the prevalence of adherence to physical activity guidelines addresses most of the shortcomings associated with the use of the Beta distribution. It is a discrete distribution that allows estimation of the prevalence of adherence every day. By more closely estimating the distribution of the probability p of an active day, it increases the prevalence of adherence among pre-schoolers to a level in line with the probability of being active on every valid day and their probability of being active on any given day. In addition, the Betabinomial distribution has little impact on the prevalence of adherence among older children.

The original Beta distribution is simple to use, and the conditional probability of adherence, given a certain

What is already known on this subject?

- The prevalence of adherence to physical activity guidelines in the population is generally estimated by averaging individual probability of adherence, based on the number of days people meet the guidelines and the number of days they are assessed.
- Given this number of active and inactive days (days assessed minus days active), the conditional probability of meeting the guidelines is distributed as a Beta (1+active days, 1 + inactive days). It assumes that the probability p of a day being active is bounded by 0 and 1 and averages 50%.
- A change in this assumption is needed when the percentage of active days in the population differs from 50%.

What does this study add?

- Using accelerometry data for children and youth aged 3 to 17 from the Canadian Health Measures Survey, the probability of adherence to physical activity guidelines is estimated using a conditional probability, given the number of active and inactive days distributed as a Betabinomial.
- For children and adolescents aged 6 or older, the probability of meeting physical activity guidelines 7 out of 7 days is similar to published estimates.
- For pre-schoolers, the Betabinomial distribution yields higher estimates of adherence to the guidelines than the Beta distribution, in line with the probability of being active on any given day.

combination of active and valid days, is always the same and does not depend on data fluctuations by survey year. Within a certain range of empirical distributions for p, with p averaging between 40% and 60%, both Beta and Betabinomial conditional probabilities yield similar results. However, the cost of this simplicity is too high when p falls outside these ranges, as can be the case for the highly skewed distribution of p for pre-schoolers.

In both cases, the prior binomial distribution assumes that each day is independent of the others. A different method is needed to account for potential correlation between days. The Betabinomial distribution also confirms that the use of a probability of adherence on at least 6 out of 7 days was the right one for the Beta distribution.

Although subject to annual fluctuation, the α and β parameters of the prior Beta distribution of p when using the Betabinomial conditional distribution were stable by age group and year, a consequence of the fact that the probability of a day being active remains the same year after year for each age group in the CHMS. Still, it is necessary to decide at what level the prior distribution of p should be estimated. The approach in this study was to use the entire population divided by age group when the guidelines or collection method differed. Future research could look at the prior distribution of p in narrower age ranges, by sex or by other variables, especially if significant differences are observed in other physical activity measures (for instance, average minutes of MVPA).

Survey data and accelerometers have inherent limitations, notably, response rates and the inability to measure certain types of activities. However, conclusions about the use of the Betabinomial distribution remain the same, regardless of how the combination of active and valid days was achieved.

This is the first time that the Betabinomial distribution has been used to calculate the prevalence of adherence to physical activity guidelines. Its advantages and lack of limitations may help overcome some limitations of the previous method. ■

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